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SEM Estimates: The long-term analysis of Pakistan's electricity demand and supply gaps

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Abstract

The electricity consumption has vital implications for economic development of any country. The study at first looks into the inter-associations of electricity demand and electricity supply for the case of Pakistan. Later, it analyzes their impacts on GDP growth in Pakistan, using structural equation modeling for a time series data of forty-five years in Pakistan. We recommend that electricity supply can momentously enhance economic growth measured by Gross Domestic Product (GDP). Results of the study predicted that electricity supply in Pakistan was empirically proven to be demand driven. Adding to it, evidences were also found which predicted that electricity demand greatly depends upon electricity prices and urbanization. Lastly, it was found that electricity supply has a positive impact on GDP, which calls for policy implication to not only boast electric energy sector but also to increase its production and manage distribution losses and thefts.

Keywords: SEM, Electricity Supply, Electricity Demand, Adjusted Demand-Supply Gaps.

Introduction

Human race is rapidly developing on the grounds of technological advances and it seems almost unfeasible to undercut the significant role of energy demand and its supply, energy shortages (crises of energy sector) and the role of efficient policies in not only proves to be a key factor in shaping the future of countries but also the world. In a book “*Why Nations Fail*: The Origins of Power, Prosperity, and Poverty (2012)” by Daron Acemoglu James A. Robinson (2012) highlights the importance of development by mentioning that it can be viewed from space i.e. from millions of miles away. The book explains why night-time Ariel views of developed countries were found to be brighter (particularly due to more use of electricity as compared to developing world). No wonder, energy demand is used as a proxy to measure the development of any country.

Table 1. Summary statistics of Electricity production (2014-15)

	Coal (% Of total)	Natural gas (% of total)	Oil (% of total)	Hydropower (% of total)	Renewable (% of total)	Nuclear power (% of total)	Access to electricity (% of pop.)	Production of Electricity (KWh)
Bangladesh	2.3	83.1	12.6	1.7	0.3	0	59.6	1095.7
China	75.4	1.8	0.1	16.8	3.6	2.1	100	5,422.20
India	72.8	5.5	1.9	11.9	5	2.9	78.7	1,193.50
Pakistan	0.1	26.3	36.9	31.9	0	4.9	93.6	97.8
Sri Lanka	12.2	0	27.9	57.5	2.3	0	88.7	12
Japan	32.4	38.7	9.8	7.5	5.5	0.9	100	1,038.50

Source: World Development Indicators, the World Bank.

The above table 1 depicts that Pakistan is lacking in production of electricity from China, India, Japan and Bangladesh. Pakistan lagging behind Bangladesh is astonishing because it is a country which is approximately less than half of the size of Pakistan but its energy production is more than half to what Pakistan is producing (1095.7 KWh). In both Japan and China, all of the population (100 percent) has access to electricity. Whereas, in Pakistan only 93 percent of population has access to electricity.

At present rest of the world is on the track to use renewable sources for electricity production but in Pakistan still non-renewable source are used for the production of electricity. Nearly, 37 percent of electricity is generated by oil which is imported and costly to country like Pakistan with less or nearly no oil reservoirs. Therefore, electricity bills in Pakistan not only capture the rate of generation from oil but also the tariffs and other costs that incurs during importation of oil. Due to this fact, on average, Pakistani consumer is paying Rs.8 / unit cost on electricity which is quite high (source: NEPRA, SDPI study, 2014-15). Shifting our electricity production methods to cheap renewable sources such as, nuclear power and hydro-electricity will not only reduce the foreign exchange losses but it will also reduce the depreciation of Pakistani rupee.

Table 2. Electricity Power Consumption, Electric power transmission and distribution losses

Electric power consumption (kWh per capita)					
Country	**Bangladesh**	**China**	**India**	**Japan**	**Pakistan**
1970s	10.68996	151.9893	97.99059	3415.688	93.54928
2010s	293.0247	3762.077	765.0034	7835.604	449.9686
Change (%)	96.35186	95.95996	87.19083	56.4081	79.20982
Electric power transmission and distribution losses (% of output)					
Country	**Bangladesh**	**China**	**India**	**Japan**	**Pakistan**
1971	31.06796	8.070501	16.36238	6.417341	26.25462
2013	13.18176	5.801504	18.45502	4.57577	17.03239
% change	-135.689	-39.1105	11.33917	-40.2461	-54.1452

Source: World Development Indicators, The World Bank. (Changes; Self Calculated)

On the other hand, when the demand side of electricity is considered (given in table 2), then it shows that if Pakistan is producing less energy than India, China and Japan then it is also consuming less electricity than these three countries. These results are in lower level of development in Pakistan in comparison to these three countries (as according to Daron Acemoglu &James A. Robinson; 2012). Similarly, India, China, Japan and Bangladesh have rapidly increased their use of electricity with a change of almost 95 percent since 1970s to 2010 and this is evident from the higher level of development in these countries.

Though, Pakistan has significantly made progress as compared to India and China in overcoming the losses which generates from the transmission and distribution of electricity. However, in comparative terms these losses are still more than Japan, China and Bangladesh. Reduction in such losses requires efficient government policy and transparency of systems which is to great extent are absent from Pakistan. The installed generation capacity of electricity in the country is around 22,000 MW, despite of this capacity, substantial amount of energy is lost due to line losses and thefts. This results in more pressure on demand-supply gap of electricity. The present analysis on electricity sector has following objectives;

i) To estimate demand-supply gap (adjusted and unadjusted) of electricity.

ii) To find determinants of electricity demand and supply, it's effect on growth through a general framework.

iii) Suggest policy implications to overcome persistent electricity crises in Pakistan.

Literature Review and Identification of Variables

Various authors have used more or less same variables to measure electricity supply. In a study by Fazale Wqahid (2016) found that electricity supply is measured by subtracting total electricity transmission and distribution loss from total electricity generation and technology variable. Determinants of ES are rainfall (mm), petroleum import, electricity transmission and distribution loss growth, final oil prices and average sale of electricity.

Syed. (2011) identifies the determinants of electricity demand in Pakistan, using a time series data of Pakistan from 1970-2010. They have applied VECM to find long run and short run dynamics between the electricity demand and determinants of electricity demand. The results of the are fascinating because they indicate that electricity remains a necessity in short run and becomes luxury in long run. However, the idea itself is contradictory because the term "luxury" refers to goods for which increase in demand is greater than the proportional increase in income. Consumption of electricity may act like luxury goods in long-run but it is certainly a necessity. This idea of electricity acting as a luxury good in long-run calls for re-visiting of thesis. Howsoever, the authors have used real income of Pakistan, consumption of electricity, prices of electricity, number of customers and electric appliances as deriving factors of electricity demand.

Al-Faris (2002) looks into the determinants of electricity for Gulf Cooperation Council (GCC) countries. GCC countries include Bahrain, Kuwait, Oman, Qatar, Saudi Arabia and UAE. The study conducts a times series analysis by capturing data from 1970-97. The author has used Johansson co-integration technique (ECM) and has found the role of GDP (real), electricity prices, and LPG prices on Electricity consumption in these countries. The short run analysis of price elasticity shows a negative relationship and is -0.04 — -0.8 (inelastic demand) and income elasticity is 0.02— -0.08 (inferior good and income inelastic). Whereas, in the long run, price elasticity shows a negative relationship with the value range of -1.09 to -2.43 (elastic demand) and income elasticity was 1.65 to 5.39 (normal good and income elastic).

Another study by Bose (1999) looks for elasticity of demand in India. The authors have used simple OLS technique using lags and claims. The results indicate that if lagged models are taken then the estimators are BLUE, though results are reliable. The authors have used data from 1985 to 1994, which is quite less for time series analysis and hence calls for re-examining of thesis because reliable range of data should be based on at least thirty years of data. The authors found short-run results using determinants of electricity consumption as real GDP per capita, electricity prices and diesel prices. The study shows that price elasticity is -0.04 to -0.65 (inelastic demand) and income elasticity is 0.49-0.81 (income inelastic) in long run.

Khan (2008) has used ARDL technique on time series data ranging from 1979-2007 for the case of Pakistan. The author aims at finding the demand for electricity in Pakistan in short run and long run. Real GDP and electricity prices are used as independent variable against electricity consumption to find price and income elasticity. The author reports the value of price elasticity SR= -0.14 to -0.29 and LR= -0.25 to -1.64 & the values of income elasticity as SR= 0.44-1.09 and LR= 0.92 to 4.72.

Chaudhry (2010) and Jamil (2002) have also found income and price elasticity in long run and short run. However, Chaudhry (2010) has used panel data for a wide range of 63 countries and employed FEM using real GDP & electricity prices as independent variables and dependent as electricity consumption. He reports only long run results for income (elastic normal good) and price (negative, inelastic demand) elasticity. On the other hand, study by (Jamil, 2002) focuses on Pakistan alone using a data set of 1960-2008. They take electricity consumption as dependent variable on real GDP and electricity prices. The study founds value of price elasticity in short run = -0.3 to-.19 and long run = -0.76 to -2.00 & the values of income elasticity as short run = 0.02-1.19 and long run = 1.42 to 4.42 (normal good and income elastic demand).

Narayan (2007) has used a panel set of G7 countries which includes Canada, Italy, UK, US, France, Germany, and Japan. The author has a data set ranging from 1978 to 2003 and looks into the residential demand elasticity for the above-mentioned countries. The technique employed by author is Panel Dynamic OLS (OLS for Panel data). The author uses real GDP per capita, electricity prices, natural gas prices as determinants of electricity consumption per capita and looks at both short run and long run dynamics. The author found income inelastic demand for normal good as electricity in short run and income elastic demand for normal good in long run.

Jaunky (2006) has worked on a larger panel of sixteen countries from Africa using data from 1971 to 2002. The author has also applied dynamic OLS and fully modified OLS to find income elasticity of electric consumptions using only real GDP per capita and electric prices as independent variables. The results show that electricity is a normal good and income elasticity turns out to be inelastic in both short run and long run for the selected sixteen countries. Though results show logically acceptable result. However, it is required that time-series analysis of each country is done and then compared with panel results to have more detailed analysis.

Similar to above time-series studies, Tariq (2009) has used data ranging from 1979-2006 for the case of Pakistan. The technique employed is Johansson co-integration technique and ECM through ARDL framework to find residential demand for electricity in Pakistan. The author uses real GDP, electricity prices, customers and temperature (new variable) to find short run and long run price and income elasticity of electricity demand. The results show that electricity is normal good and income elasticity is elastic in both short run and long run. On the same hand, there exists negative price inelasticity for demand in both short run and long run. The result provided by the study is contradictory to Syed (2011).

Another study by WP1 (2007) has focused merely on the European electricity sector. However, for a comparative analysis and general setting of model, this project may appear helpful. A considerable amount of literature can be found on Electricity demand analysis in Pakistan. However, much lesser work has been done on the subject of electricity supply in Pakistan. Fazale Wqahid (2016) forecasts the electricity supply for Pakistan up to the years of 2025. The authors have ARIMA technique to forecast electricity supply and simple OLS is used to find determinants of electricity supply. The study found that all variables including total petroleum imports, electricity transmission and distribution loss, prices of petroleum and technology had significant impact on electricity supply. However, we found that rainfall and prices of electricity had negative effect. All of the above-mentioned arguments made a great deal of contribution towards the literature of energy economics. However, for the case of Pakistan, institutions affect electricity prices and thus real GDP per-capita, which has been ignored by almost all of the papers. No significant study was found which used data up till 2015 to find determinants of electricity demand in Pakistan. On the same grounds, electricity demand fluctuates a great deal in summers and winter i.e. with seasonal change. Hence, giving figures for overall year can be misleading. It is required that analysis is done on monthly bases and the variable of temperature/seasonal shift is added in empirical models. A study by Lin (2003) has also used money supply as a significant variable to determine energy consumption in China. The significance of this variable can also be tested for Pakistan, that if it derives the electricity demand or not. Fuel prices can also have an impact on the electricity prices especially for the case of Pakistan, when much of the electricity is produced by oil (37 percent, see table 1). A study by De Vita (2006) has found the role of fuel prices on electricity consumption for the case of Namibia and hence, it may be added to the case of Pakistan. 26% (see table 1) of electricity is produced by natural gas in Pakistan and hence the natural gas prices may also affect price of electricity and also energy consumption. No above-mentioned study has used natural gas prices except Narayan (2007) and fuel prices as determinant to electricity consumption.

Electricity demand-supply gaps

Figure 1 (refers to table 1 in appendix) shows that electricity supply and demand have both increased in from 1971 to 2015. On the same hand, it shows that gap between supply and demand is also increasing, but has fluctuating figures. The supply-demand gap initially decreased in 1972 and then grew substantially from 1997. The positive growth of gap shows that electricity supply has always been more than electricity demand. Note, that this gap is calculated by unadjusted supply and demand.

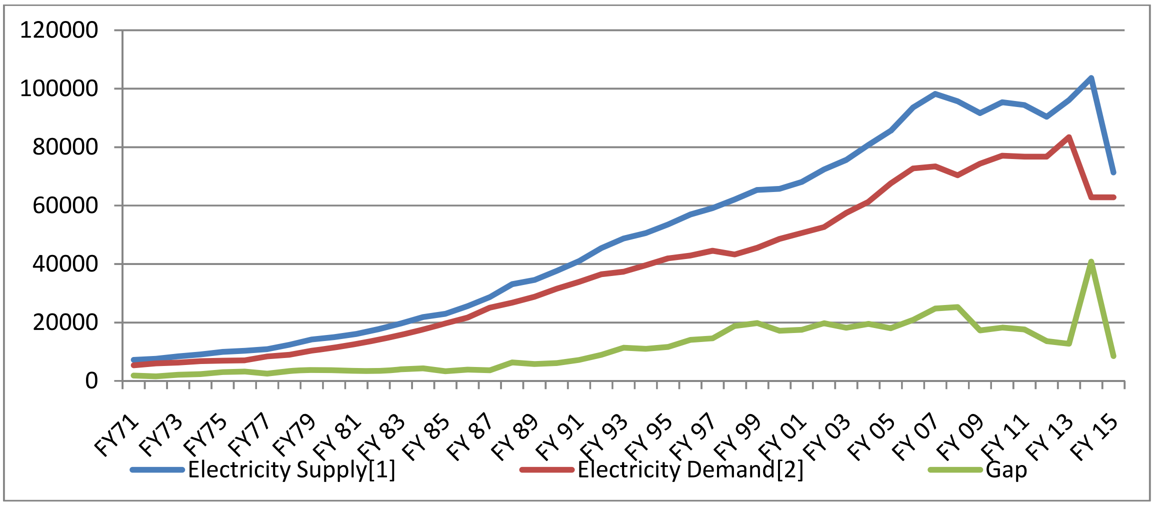

Figure 1. Demand-Supply gap of electricity (MWH) (Source: Author's calculations)

The issue arises from the above analysis is that if supply is more than demand then why there are electricity shortages / crises in Pakistan? One reason is that much of the electricity is lost during the process of distribution. In other words, loss in electricity may be leading to shortage in supply. These losses occur in transmission between sources of supply and points of distribution, particularly in the process of distribution to consumers. Note that Generation Capacity (GWH) of electricity is used as proxy of electricity supply. Total Electricity (GWH) is used as proxy of electricity supply. Gap (MWH) is calculated by subtracting electricity demand from electricity supply. Not only that, theft of electricity may also lead to shortage of electricity and increase of the burden in electricity prices. Considering, the mentioned issues, the supply of electricity has been adjusted to line losses and thefts (see Figure 2).

Figure 2 (refer to table 5 in appendix for details) shows that electricity loss due to above mentioned reasons may not only be increasing, but leads to nearly 24 percent (on average) of total loss in electricity each year from 1970-2015. Although in the last few years; 2005 to 2015, the Electric power transmission and distribution losses (% of output) has decreased to 18 %, but still remains worrisome. The gap between electricity adjusted supply and demand has been observed negative for most of the years in Pakistan history from 1971 to 32015, which calls for policy implication to boosting of electricity supply.

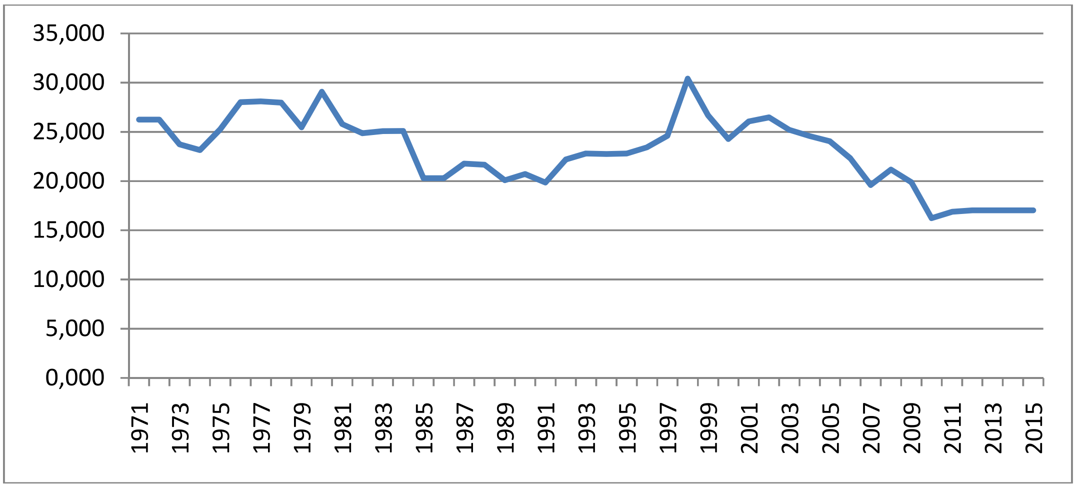

Figure 2. Electric power transmission and distribution losses (% of output)
Source: WDI, 2016.

Methodology

For each region, a separate Ψ variable is included, and these represent the residual influences. Simply stated, this variable can be interpreted as the combined influences of areas outside the model and the influence of a brain region upon itself (McIntosh and Gonzalez-Lima, 1992). Mathematically, the above model as presented in figure 3 can be written as a set of structural equations as;

$$Growth = d\,(ES) + c\,(Aid) + b\,(INV) + a\,(TO) + \psi_{Growth} + e_1 \quad (1)$$

$$ED = g\,(pop) + I\,(URB) + j\,(E_F) + \psi_A \quad (2)$$

$$ES = h\,(ED) + e\,(Aid) + f\,(oil) + k\,(E_F) + \psi_{electricity\ supply} + e_3 \quad (3)$$

Note that in above equation; a separate Ψ variable is included, which represent the residual influences. The SEM is used to test if electricity demand (ED) is affected by population growth (pop) & urbanization (URB). Literature shows that a growth in population and increase in urbanization, creates demand for more electricity and hence positively (expected sign) affects electricity demand. Whereas, electricity supply is affected by fuel prices (E_F), foreign aid and assistance (Aid) in Pakistan. An increase in fuel prices, may affect the production price of electricity from oil which is 37 percent of electricity production in Pakistan as per year 2014 (thus, expected sign is positive). Similarly, nearly 32 percent of electricity is produced by hydro-electricity. Upon calculating correlation of aid and electric losses, we found that these two variables are highly correlated (-0.68); showing that aid reduces electricity losses and can be tested.

Considering the nature of electricity issue, structural equation modeling (SEM) technique has been used to develop a general model framework, to explore key determinants of electricity supply and electricity demand jointly at first, and then their impact on overall growth of Pakistan for a time-series period of 1971-2016. Figure 4 shows three independent equations with the main variables as electricity demand, electricity supply and growth connected by arrows showing their anatomical connections. The arrows denoting a b, c, d e f g, h, I, j and k are the path ways which are calculated by a series of algebraic manipulations and represents effective connectivity among variables. The model graphics can be shown below in figure 3;

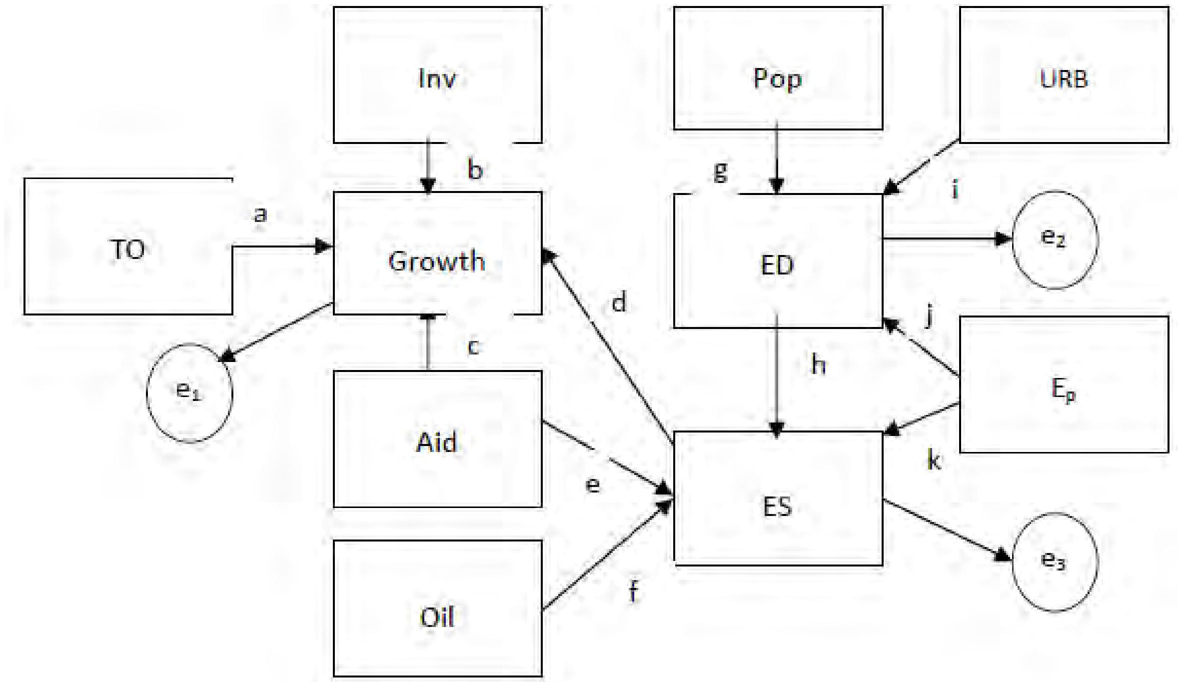

Figure 3. Path model for Electricity Demand and Supply (Source Developed by the Authors)

Most of the studies has worked on finding determinants of demand and supply of electricity, but no significant study has looked into the impacts of electricity demand and supply (adjusted for distribution and theft losses) in determining the economic growth of Pakistan. Also, it has been completely neglected in various studies that how determinants of electricity supply and demand may have indirect effect on growth. Last but not the least, the role of electricity prices on demand and supply, appears to be the most important variable in looking into the dynamic nature of two dependent variables. Previous studies have looked into determinants of demand or supply of electricity but they did it separately, which appears to be a weak approach. We deem here that electricity supply is demand driven (expected sign of ED will be positive in supply equation) in Pakistan and hence can't be estimated alone. Others have completely missed out their joint interaction on growth, which may lead to deficient results, since demand and supply are two shear blades of scissor and must not be looked separately. This adds to the novelty of this study.

Results

The results for structural equation are reported for three equations (growth equation, electricity supply equation & electricity demand) in table 3 (below). The results for equation-1(Growth equation) shows that increase in electricity supply leads to a positive impact on growth, which demonstrates more the supply of electricity more will be economic development in country. The results show that all variables were found to have a significant impact on growth except trade openness.

The variable may contribute to growth, if GNP was taken instead of GDP as a dependent variable. The interesting development in previous models of electricity demand and supply is that the present study empirically tests if supply of electricity is demand driven in Pakistan or not. This is related to the fact that demands for electricity increases when there is a change of season in Pakistan. In summers, the demand for electricity increases and so do the supply.

For the last equation-2 (electricity demand) showed a positive impact of urbanization and negative impact of electricity prices on electricity demand. As per the law of demand & supply, electricity prices were found to be positively significant with supply and negatively significant with electricity demand. Another important aspect of these results is that, only increase in population will not lead to increase in demand for electricity, thus supply of electricity and growth. The results of population were found to be bringing an insignificant impact on electricity Pakistan as even today half of Pakistan's population is residing in rural areas. It is required that rural areas are made more advanced up to the level of urban areas; which would latter drive more energy demand and thus technological changes leads to growth in the long run.

Table 3. Empirical Results

Dep. Var	Coef.	Std.	Z	P>z
Equation 1: LNGDP (R Square = 0.87)				
ES2	2e-05	1e-05	1.9	0.057
LNGFCF	8e-01	6e-02	13.6	0
TO	2e-05	8e-05	0.27	0.786
AID	-5e-10	3e-10	-1.96	0.05
_CONS	4e+00	1e+00	3.81	0
Equation 2: ES2 (R Square = 0.98)				
ED	0.95	0.1	16.97	0
AID	0.00	0.0	-1.8	0.072
EP	833.90	396.8	2.1	0.036
LNOP	993.70	1150.4	0.86	0.388
Equation 3: ED (R Square = 0.94)				
EP	-2060.5	1170.8	-1.76	0.078
URB	8413.3	3096.3	2.72	0.007
LNPOP	-4117.0	25472.5	-0.16	0.872
_CONS	-144518.8	379559.2	-0.38	0.703
LR Test Of Model Vs. Saturated: Chi2(20) = 50.24, Prob > Chi2 = 0.0002				

Source: Author's calculations.

For the equation-3 (electricity supply), we found that electricity supply is positively affecting the electricity demand and hence we may conclude that electricity supply is demand drive. We also found that Aid has negative impact on electricity supply (adjusted for distribution and theft losses). We can thus say that as aid increases, it has led to decrease in thefts and distribution losses. China has also recently given aid to Pakistan for setting up four new nuclear power reactors; an example is of China's $35 billion investment in power generation infrastructure in recent years. USAID has supported infrastructure for electricity generation (introduction of smart meters) to Pakistan and almost $300 million in new energy aid was given by international donors in 2012. It is important to note here that It doesn't refer that we may become aid depend to emerge from electricity crises. The analysis only shows the reasons why electricity shortages have reduced in the previous years. The need is for long term policy, based on strong institutional structures to overcome energy crises in Pakistan. However, the impact of oil supply is insignificant on electricity supply. The reason being that although it is the biggest source of supply but electricity produced from oil is only 37% and rest of the electricity is generated jointly by nuclear, coal, natural gas & hydro-sources, which are not included in model for simplicity.

Concluding the above argument, the imperative results of study are that electricity supply in Pakistan is highly dependent upon electricity demand; which may be increased with cutting down of prices and increase in urbanization/ turning rural areas into developed cities. The results also showed that electricity supply along with investment, aid and trade openness leads to growth. Stability tests, equation-wise Wald tests and Chi square probability shows that model is stable and the results can be taken as reliable (for details of diagnostic tests, pl. see appendix).Last but not the least, the model captures up to 98 percent of variations, overall. However, the growth equation showed only 87 percent of variation.

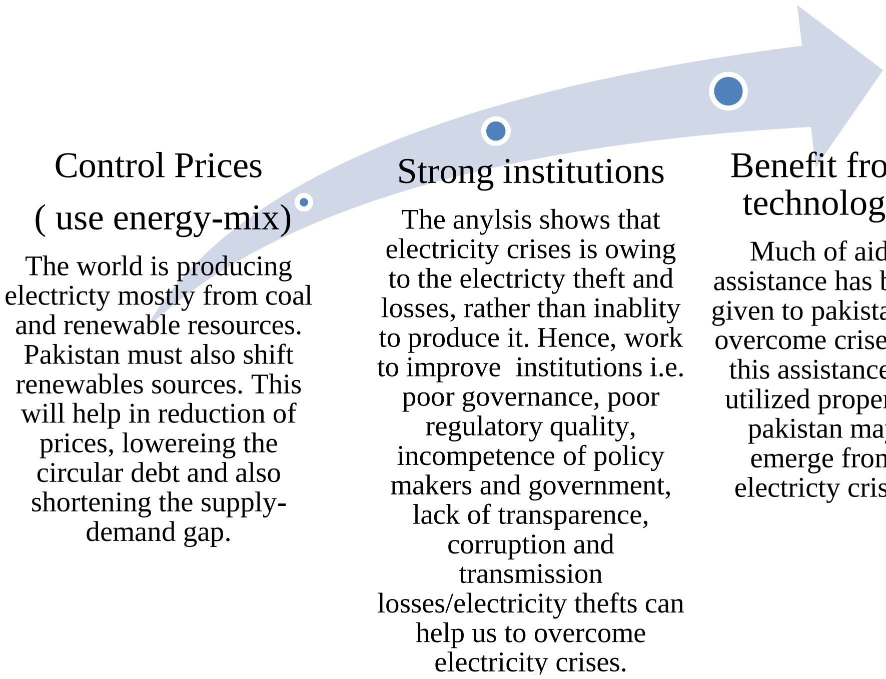

Figure 4. Policy perspective (Source: Designed by Authors)

Conclusions and Policy Implication

Electricity demand-supply gap (adjusted and unadjusted) analysis indicates that major reason for the present electricity crises is the substantial amount of electricity losses due to thefts and distribution losses not the inability to produce/supply of electricity in Pakistani which leads to shortage of supply. Despite of few years in Musharraf regime (1999-2007), Pakistan on average hardly ever had a surplus of electricity demand and supply gap. The surplus in electricity demand and supply gap in 2005-2008 in Musharraf regime was owing to massive amount of loans which were given to

Pakistan. Another important cause of electricity crisis is high cost of electricity production; bill incurring to consumers was almost in the range of Rs. 9 to Rs 15 per unit (2016); which affects supply because it is demand driven in Pakistan. These high electricity prices (appear to be a necessity in short run and long run), leads to electricity thefts, which creates more pressure on people who are paying bills and this further leads to shortage of electricity supply. SEM technique showed important empirical conclusions for macro-economic model for electricity demand and supply. Results depicted that electricity supply in Pakistan is highly dependent upon electricity demand; which may be amplified by cutting down of electric prices and with increase in urbanization/ turning rural areas into developed cities. The results also showed that electricity supply along with investment, aid and trade openness leads to GDP growth. Hence, a policy framework to enhance electricity supply may swank overall economic growth of Pakistan. We prove that electricity supply is demand driven in Pakistan. Whilst, electricity demand is driven by electricity prices and increase in urbanization. The solution to electricity crises lies in simple three-pronged strategy;

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Appendix

Table A1. Demand-Supply Gap of electricity (MWH)

Year	Electricity Supply[1]	Electricity Demand[2]	Gap [3]
FY71	7,202	5,332	1,870
FY72	7,572	6,004	1,568
FY73	8,377	6,256	2,121
FY74	9,064	6,721	2,343
FY75	9,941	6,933	3,008
FY76	10,319	7,067	3,252
FY77	10,877	8,372	2,505
FY78	12,375	8,977	3,398
FY79	14,174	10,347	3,827
FY80	14,974	11,384	3,590

Data Source: Various Issues of PES. Gap Self-calculated.

Table A2. Demand-Supply Gap of electricity (MWH)

Year	Electricity Supply	Electricity Demand	Gap
FY 81	16,062	12,698	3,364
FY 82	17,688	14,150	3,538
FY 83	19,697	15,730	3,967
FY 84	21,873	17,584	4,289
FY 85	23,003	19,665	3,338
FY 86	25,589	21,697	3,892
FY 87	28,703	25,075	3,628
FY 88	33,091	26,787	6,304
FY 89	34,562	28,769	5,793
FY 90	37,660	31,534	6,126

Data Source: Various Issues of PES. Gap Self-calculated.

Table A3. Demand-Supply Gap of electricity (MWH)

Year	Electricity Supply	Electricity Demand	Gap
FY 91	41,042	33,878	7,164
FY 92	45,440	36,492	8,948
FY 93	48,751	37,381	11,370
FY 94	50,640	39,621	11,019
FY 95	53,545	41,924	11,621
FY 96	56,946	42,914	14,032
FY 97	59,125	44,572	14,553
FY 98	62,104	43,296	18,808

[1] "Generation Capacity (GWH) of electricity" is used as proxy of electricity supply.
[2] "Total Electricity (GWH)" is used as proxy of electricity supply.
[3] Gap (MWH) is calculated by subtracting electricity demand from electricity supply.

FY 99	65,402	45,586	19,816
FY 00	65,751	48,585	17,166

Data Source: Various Issues of PES. Gap Self-calculated

Table A4. Demand-Supply Gap of electricity (MWH)

Year	Electricity Supply	Electricity Demand	Gap
FY 01	68,117	50,622	17,495
FY 02	72,406	52,656	19,750
FY 03	75,682	57,491	18,191
FY 04	80,826	61,327	19,499
FY 05	85,628	67,603	18,025
FY 06	93,629	72,712	20,917
FY 07	98,213	73,400	24,813
FY 08	95,661	70,371	25,290
FY 09	91,616	74,348	17,268
FY 10	95,358	77,099	18,259
FY 11	94,384	76,761	17,623
FY 12	90,394	76,789	13,605
FY 13	96,121	83,409	12,712
FY 14	103,670	62,846	40,824
FY 15	71,362	62,846	8,516

Data Source: Various Issues of PES. Calculated by the Authors.

Table A5. Adjusted Demand and supply Gaps (MWH)

Year	Old Gap	Adj. gap	Year	Old Gap	Adj. Gap	Year	Old Gap	Adj. Gap
FY71	1,870	-20.8	FY 81	3364	-779	FY 91	7164	-983.251
FY72	1,568	-420	FY 82	3538	-860	FY 92	8948	-1135.19
FY73	2,121	133	FY 83	3967	-973	FY 93	11370	255.0492
FY74	2,343	244	FY 84	4289	-1200	FY 94	11019	-508.444
FY75	3,008	497	FY 85	3338	-1329	FY 95	11621	-593.656
FY76	3,252	360.2	FY 86	3892	-1299	FY 96	14032	688.577
FY77	2,505	-552	FY 87	3628	-2621	FY 97	14553	1.714906
FY78	3,398	-64	FY 88	6304	-868	FY 98	18808	-80.0525
FY79	3,827	219	FY 89	5793	-1148.1	FY 99	19816	2363.867
FY80	3,590	-765	FY 90	6126	-1679.3	FY 00	17166	1209.925

Source: Author's calculations

Table A6. Wald test for Equations

Wald test for Equations			
Observed	**chi2**	**df**	**p**
Ln gdp	340.04	3	0
es2	2283.45	4	0
Ed	786.66	3	0

Source: Author's calculations

Table A7. Equation-level goodness of fit

Depvars	Fitted	predicted	residual	R-squared
Lngdp	3.60741	3.196076	0.411334	0.885975
es2	6.57E+08	6.45E+08	1.24E+07	0.981183
Ed	5.99E+08	5.67E+08	3.17E+07	0.94703
Overall				0.99418

Source: Author’s calculations

Table A8. Stability Condition

Eigen value	Modulus
0	
0	0
0	0
Stability index	0

Source: Author’s calculations
Note: All eigen values are rounded off as they all lie below 0.5, hence, we conclude that the model is stable.